Extended EPON PMDs

Analysis of extreme overload scenarios

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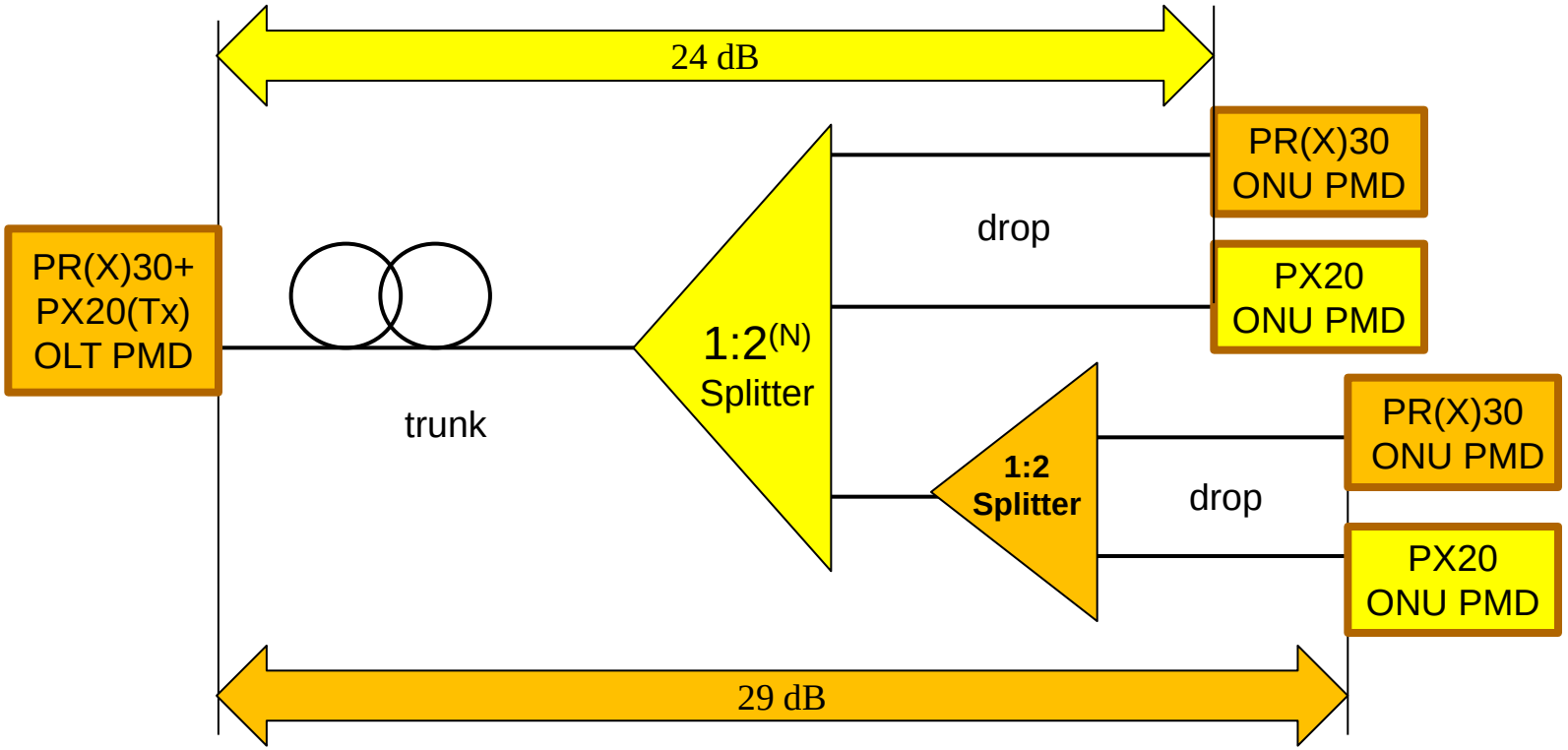
Agenda

- Coexistence scenarios in the worst cases
  - PX20 and PR(X)30 coexistence
  - PR(X)20 and PR(X)30 coexistence
  - PR(X)20, PR(X)30 and PR(X)40 coexistence
  - PX20 and PX30 coexistence
  - PX20, PX30 and PX40 coexistence

PX20 and PR(X)30 coexistence



- In this scenario, an operator is assumed to migrate from 24dB ODN with PX20 class devices to 29dB ODN, by locally adding 1:2 splitters in selected locations where customer demand is higher.
- The worst case is that operator send the user the wrong ONU, PR30 or PRX30 ONU is mistaken at the 24 dB ODN, and PX20 ONU is also in the wrong place at 29 dB ODN.

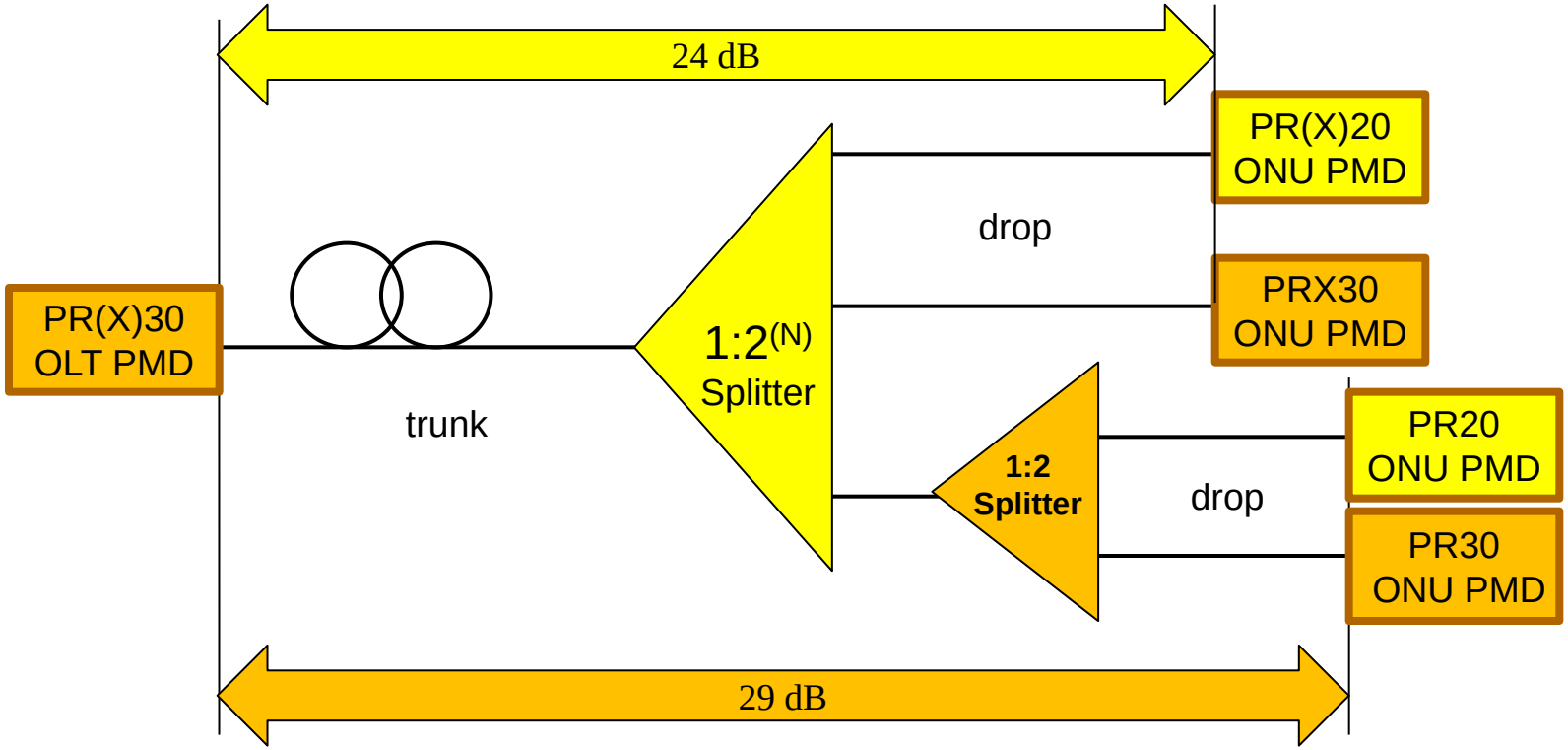
Numeric proof of coexistence (1)

- **PR30 and PRX30 class ONUs with PR(X)30 class OLT at PX20 ODN**
  - **Downstream (10G)**
    - Power budget: +2 – 1.5 – (–28.5) = 29 dB
    - ODN loss: 5.52+14= 19.52 dB
    - Maximum power level at ONU Rx: +5 – 1.5 – 19.52 = -16.02 dBm
    - Power budget margin: +9.48 dB
    - Damage threshold of ONU Rx: –9 dBm >> –16.02 dBm
    - Conclusions: both ONUs receive optical signal within sensitivity limit of their Rx
  - **Upstream (1G)**
    - Power budget: +0.62 – 1.4 – (– 29.78) = 29 dB
    - ODN loss: : 8.36+14 = 22.36 dB
    - Maximum power level at OLT Rx: +5.62 – 1.4 – 22.36 = -18.14 dBm
    - Power budget margin: +6.64 dB
    - Damage threshold of OLT Rx: –5dBm >> –18.14 dBm
    - Conclusions: PRX30 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold
  - **Upstream (10G)**
    - Power budget: 4 – 3 – (– 28.0) = 29 dB
    - ODN loss: **:** 8.36+14 = 22.36 dB
    - Maximum power level at OLT Rx: +9 – 3 – 22.36 = -16.36 dBm
    - Power budget margin: +6.64 dB
    - Damage threshold of OLT Rx: –5dBm >> – 16.36 dBm
    - Conclusions: PR30 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold

Numeric proof of coexistence (2)

- **PX20 class ONUs with PR(X)30 class OLT at PR(X)30 ODN**
  - **Downstream (1G)**
    - Power budget: +2 – 2.3 – (–24) = 23.7 dB
    - ODN loss 5.52+17.41= 22.93 dB
    - Maximum power level at ONU Rx: +7 – 2.3 – 22.93 = – 18.23 dBm
    - Power budget margin: +0.77 dB
    - Damage threshold of ONU Rx: +7 dBm >> –18.23 dBm
    - Conclusions: PX20 ONU receive optical signal within sensitivity limit of their Rx
  - **Upstream (1G)**
    - Power budget: -1 – 1.8 – (– 29.78) = 26.98 dB
    - ODN loss: 8.36+17.41= 25.77 dB
    - Maximum power level at OLT Rx: +4 – 1.8 – 25.77 = – 23.57 dBm
    - Power budget margin: +1.21 dB
    - Damage threshold of OLT Rx: –5dBm >> –23.57 dBm
    - Conclusions: PRX30 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold

PR(X)20 and PR(X)30 coexistence



- In this scenario, an operator is assumed to migrate from 24dB ODN with PR(X)20 class devices to 29dB ODN, by locally adding 1:2 splitters in selected locations where customer demand is higher.
- The worst case is that operator send the user the wrong ONU, PR30 or PRX30 ONU is mistaken at the 24 dB ODN, and PR20 ONU is also in the wrong place at 29 dB ODN.

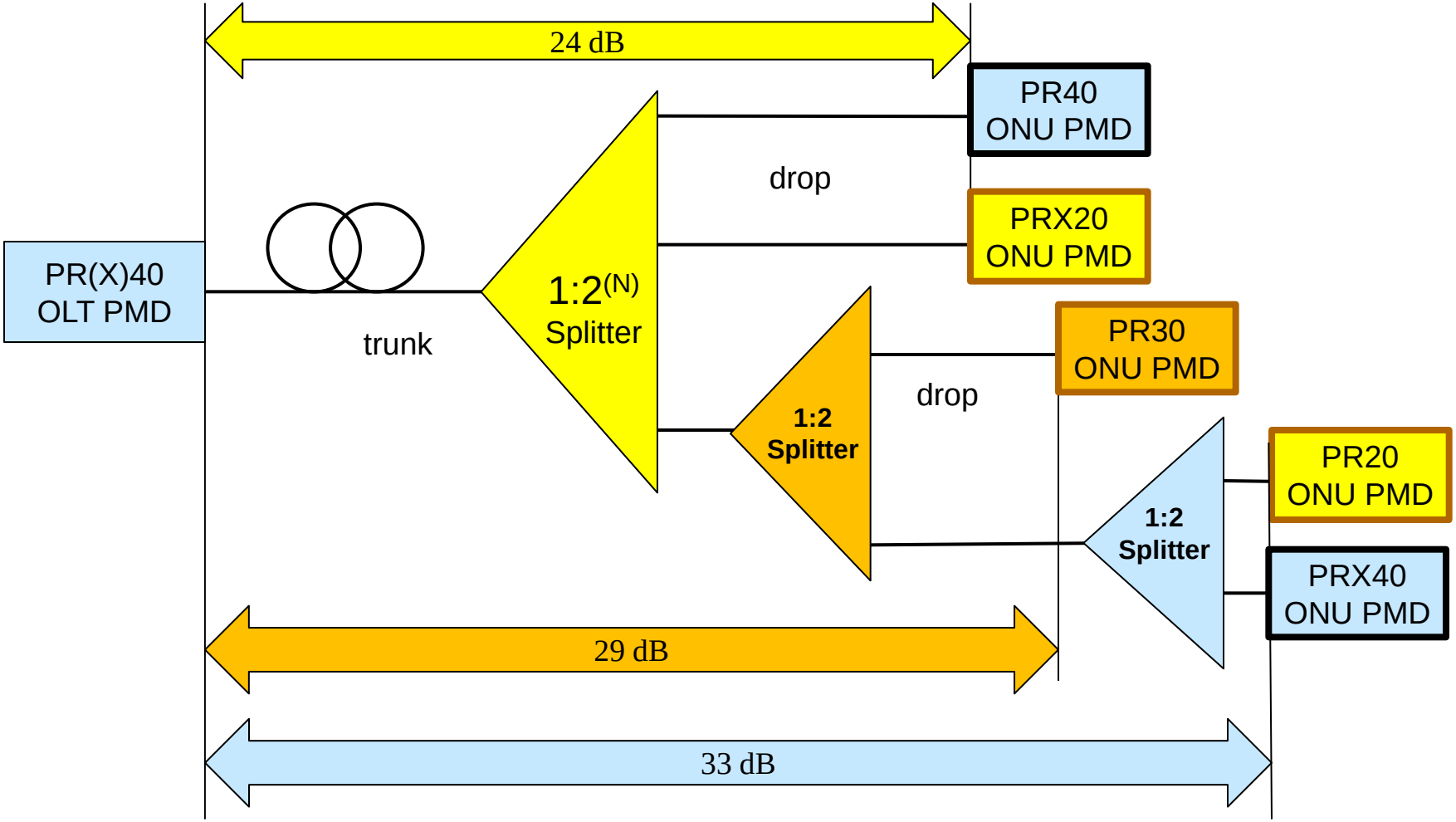
Numeric proof of coexistence (1)

- **PR30 and PRX30 class ONUs with PR(X)30 class OLT at PR(X)20 ODN**
  - **Downstream (10G)**
    - Power budget: +2 – 1.5 – (–28.5) = 29 dB
    - ODN loss: 5.52+14= 19.52 dB
    - Maximum power level at ONU Rx: +5 – 1.5 – 19.52 = -16.02 dBm
    - Power budget margin: +9.48 dB
    - Damage threshold of ONU Rx: –5dBm >> –16.02 dBm
    - Conclusions: both ONUs receive optical signal within sensitivity limit of their Rx
  - **Upstream (1G)**
    - Power budget: +0.62 – 1.4 – (– 29.78) = 29 dB
    - ODN loss: 8.36+14 = 22.36 dB
    - Maximum power level at OLT Rx: +5.62 – 1.4 – 22.36 = -18.14 dBm
    - Power budget margin: +6.64 dB
    - Damage threshold of OLT Rx: –5dBm >> –18.14 dBm
    - Conclusions: PRX30 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold
  - **Upstream (10G)**
    - Power budget: 4 – 3 – (– 28.0) = 29 dB
    - ODN loss 8.36+14 = 22.36 dB
    - Maximum power level at OLT Rx: +9 – 3 – 22.36 = -16.36 dBm
    - Power budget margin: +6.64 dB
    - Damage threshold of OLT Rx: –5dBm >> – 16.36 dBm
    - Conclusions: PR30 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold

Numeric proof of coexistence (2)

- **PR20 and PRX20 class ONUs with PR(X)30 class OLT at PR(X)30 ODN**
  - **Downstream (10G)**
    - Power budget: +2 – 1.5 – (–20.5) = 21 dB
    - ODN loss: 5.52+17.41= 22.93 dB
    - Power budget margin: -1.93 dB
    - Conclusions: Given that the power budget margin is negative, the link will not work. This means that PR20 or PRX20 will not work with PR(X)30 class ODN.

PR(X)20, PR(X)30 and PR(X)40 coexistence



- PR(X)40 OLT and ONU PMDs use parameters proposed in http://www.ieee802.org/3/EXTND_EPON/public/1201/ExEPON_1201_li_2.pdf

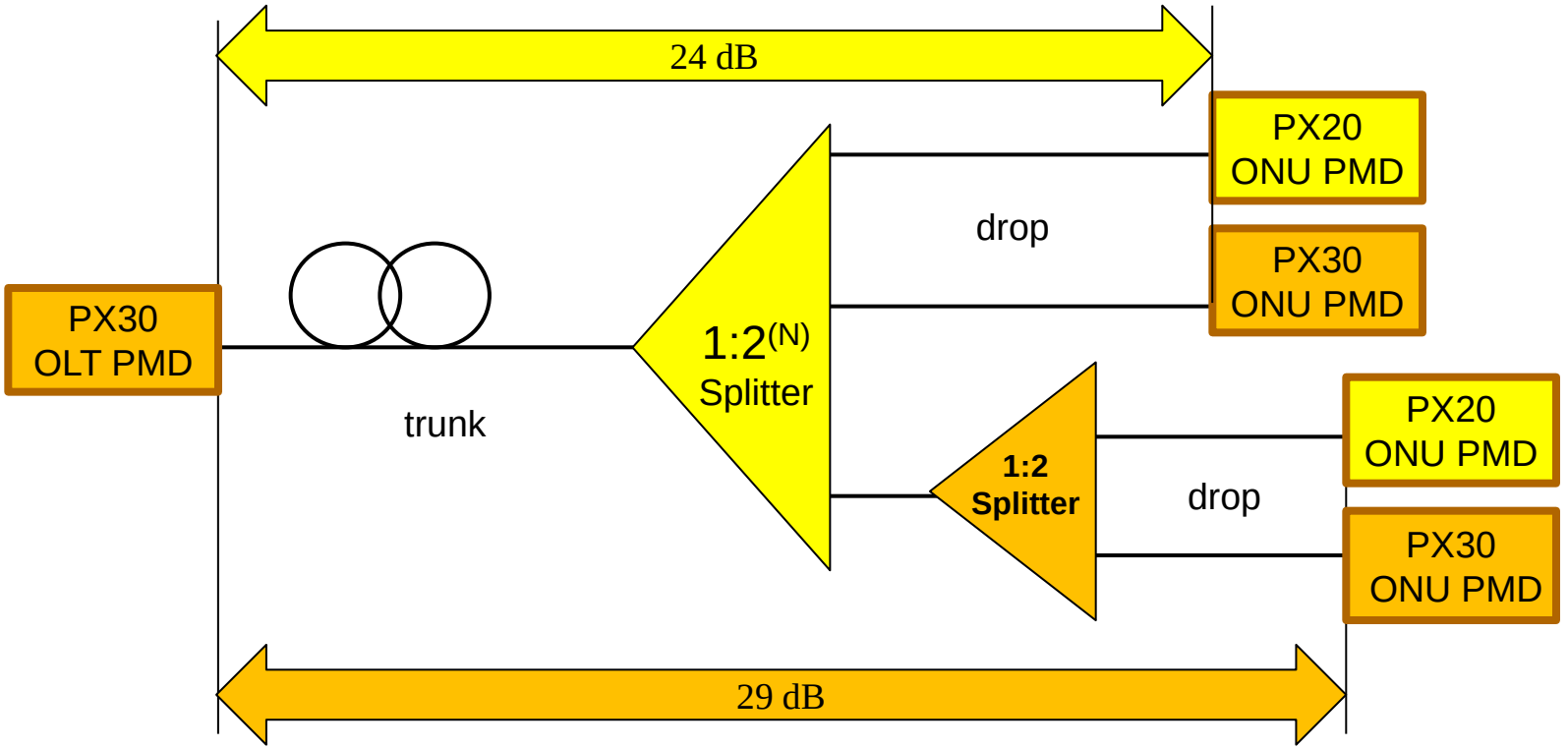
Numeric proof of coexistence (1)

- **PR40 and PRX40 class ONUs with PR(X)40 class OLT at PR(X)20 ODN**
  - **Downstream (10G)**
    - Power budget: +5 – 1.5 – (–29.5) = 33 dB
    - ODN loss: 5.52 + 14 = 19.52 dB
    - Maximum power level at ONU Rx: +9 – 1.5 – 19.52 = – 12.02 dBm
    - Power budget margin: +13.48 dB
    - Damage threshold of ONU Rx: –5 dBm >> –12.02 dBm
    - Conclusions: both PR40 and PRX40 ONUs receive optical signal within sensitivity limit of their Rx
  - **Upstream (1G)**
    - Power budget: +2 – 1 – (– 32) = 33 dB
    - ODN loss: 8.36 + 14 = 22.36 dB
    - Maximum power level at OLT Rx: +7 – 1 – 22.36 = – 16.36 dBm
    - Power budget margin: +10.64 dB
    - Damage threshold of OLT Rx: –5dBm >> –16.36 dBm
    - Conclusions: PRX40 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold
  - **Upstream (10G)**
    - Power budget: +6 – 2 – (– 29.0) = 33 dB
    - ODN loss 8.36 + 14 = 22.36 dB
    - Maximum power level at OLT Rx: +10 – 2 – 22.36 = – 14.36 dBm
    - Power budget margin: +10.64 dB
    - Damage threshold of OLT Rx: –5dBm >> – 14.36 dBm
    - Conclusions: PR40 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold

Numeric proof of coexistence (2)

- **PR20 and PRX20 class ONUs with PR(X)40 class OLT at PR(X)30 ODN**
  - **Downstream (10G)**
    - Power budget: +5 – 1.5 – (–20.5) = 24 dB
    - ODN loss: 5.52+17.41 = 22.93 dB
    - Maximum power level at ONU Rx: +9 – 1.5 – 22.93 = – 15.43 dBm
    - Power budget margin: +1.07 dB
    - Damage threshold of ONU Rx: –5dBm >> –15.43 dBm
    - Conclusions: both ONUs receive optical signal within sensitivity limit of their Rx
  - **Upstream (1G)**
    - Power budget: -1 – 1.8 – (– 32) = 29.2 dB
    - ODN loss: 8.36+17.41 = 25.77 dB
    - Maximum power level at OLT Rx: +4 – 1.8 – 25.77 = – 23.57 dBm
    - Power budget margin: +3.43 dB
    - Damage threshold of OLT Rx: –5dBm >> –23.57 dBm
    - Conclusions: PRX40 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold
  - **Upstream (10G)**
    - Power budget: -1 – 3 – (– 29.0) = 25 dB
    - ODN loss: 8.36+17.41 = 25.77 dB
    - Power budget margin: - 0.77 dB
    - Conclusions: The power budget margin is negative, so this link will not work. This means that PR20 or PRX20 will not work with PR(X)30 class ODN.

PX20 and PX30 coexistence



- In this scenario, we examine the coexistence between PX20 and PX30 ONUs on the same ODN, representing a migration and evolution scenario for operators that have already deployed PX20 compatible ODN.
- PX30 OLT and ONU PMDs use parameters proposed in http://www.ieee802.org/3/EXTND_EPON/public/1201/ExEPON_1201_li_2.pdf

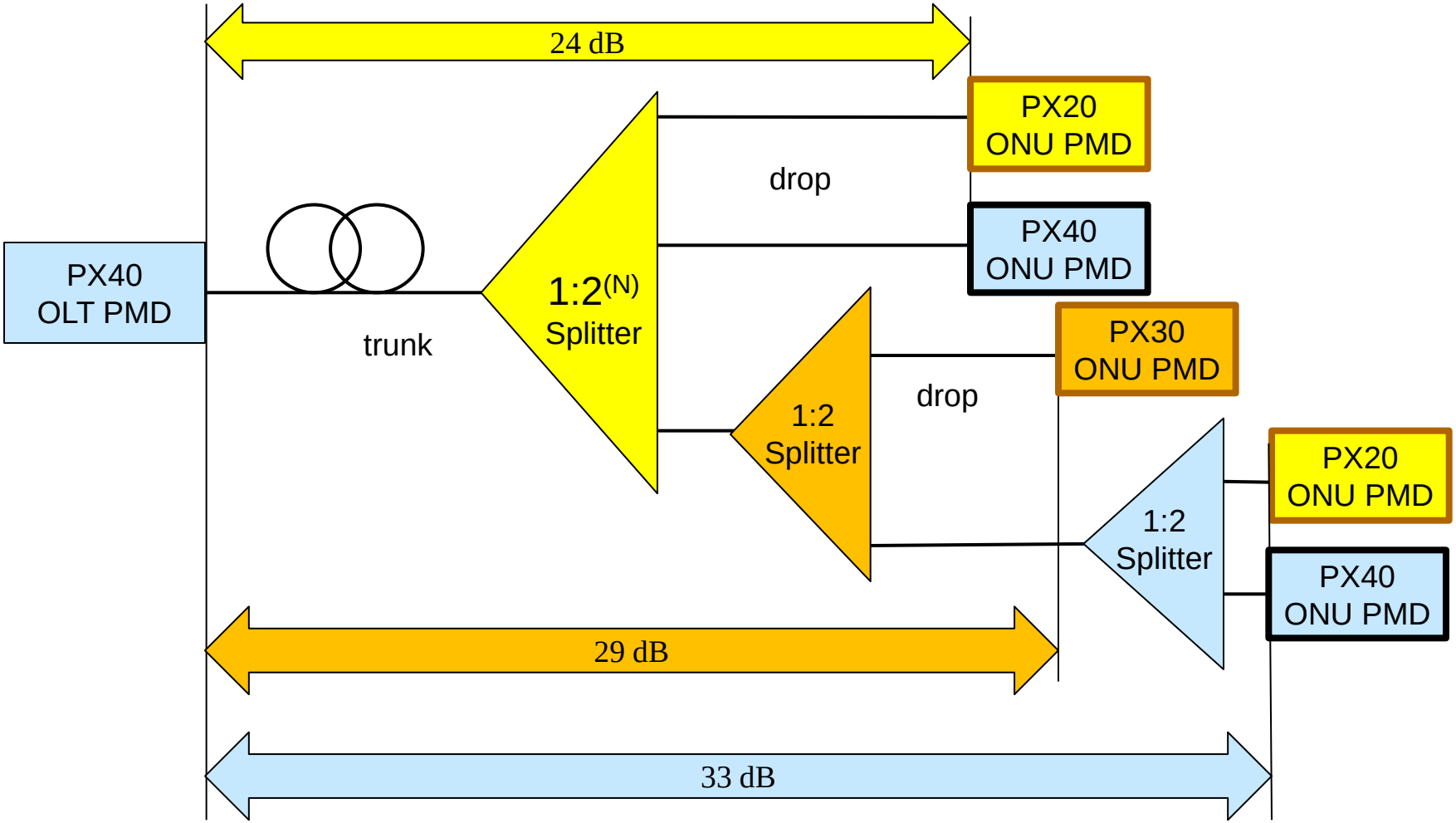
Numeric proof of coexistence (1)

- **PX30 class ONUs with PX30 class OLT at PX20 ODN**
  - **Downstream (1G)**
    - Power budget: +3 – 1.0 – (–27) = 29 dB
    - ODN loss: 5.52+14 =19.52 dB
    - Power budget margin: +9.48 dB
    - Maximum power level at ONU Rx: +7 – 1.0 – 19.52 = – 13.52 dBm
    - Damage threshold of ONU Rx: +4 dBm >> –13.52 dBm
    - Conclusions: PX30 ONU receive optical signal within sensitivity limit of their Rx
  - **Upstream (1G)**
    - Power budget: +1 – 2.0 – (– 30) = 29.0 dB
    - ODN loss: 8.36+14= 22.36 dB
    - Maximum power level at OLT Rx: +4 – 2.0 – 22.36 = – 20.36 dBm
    - Power budget margin: +6.64 dB
    - Damage threshold of OLT Rx: –3dBm >> –20.36 dBm
    - Conclusions: PX30 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold

Numeric proof of coexistence (2)

- **PX20 class ONUs with PX30 class OLT at PX30 ODN**
  - **Downstream (1G)**
    - Power budget: +3 – 1.0 – (–24) = 26 dB
    - ODN loss: 5.52+17.41 =22.93 dB
    - Maximum power level at ONU Rx: +7 – 1.0 – 22.93 = – 16.93 dBm
    - Power budget margin: +3.07 dB
    - Damage threshold of ONU Rx: +7 dBm >> –16.93 dBm
    - Conclusions: PX20 ONU receive optical signal within sensitivity limit of their Rx
  - **Upstream (1G)**
    - Power budget: -1 – 1.8 – (– 30) = 27.2 dB
    - ODN loss: 8.36+17.41 =25.77
    - Maximum power level at OLT Rx: +4 – 1.8 – 25.77 = – 23.57 dBm
    - Power budget margin: +1.43 dB
    - Damage threshold of OLT Rx: –3dBm >> –23.57 dBm
    - Conclusions: PX30 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold

PX20, PX30 and PX40 coexistence under ExEPON



- PX40 and PX30 OLT and ONU PMDs use parameters proposed in http://www.ieee802.org/3/EXTND_EPON/public/1201/ExEPON_1201_li_2.pdf

Numeric proof of coexistence (1)

- **PX40 class ONUs with PX40 class OLT in the PX20 ODN**
  - **Downstream (1G)**
    - Power budget: +4 – 1.0 – (–30) = 33 dB
    - ODN loss: 5.52+14 = 19.52 dB
    - Power budget margin: +13.48 dB
    - Maximum power level at ONU Rx: +7-1-19.52 = -13.52 dBm
    - Damage threshold of ONU Rx: –3dBm >> –13.52 dBm
    - Conclusions: PX40 ONU receive optical signal within sensitivity limit of their Rx
  - **Upstream (1G)**
    - Power budget: +2 – 1.0 – (– 32) = 33 dB
    - ODN loss: 8.36+14 = 22.37 dB
    - Maximum power level at OLT Rx: +7 – 1.0 – 22.37 = – 16.37 dBm
    - Power budget margin: +10.63 dB
    - Damage threshold of OLT Rx: –3dBm >> –16.37 dBm
    - Conclusions: PX40 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold

Numeric proof of coexistence (2)

- **PX20 class ONUs with PX40 class OLT at the PX40 ODN**
  - **Downstream (1G)**
    - Power budget: +4 – 1.0 – (–24) = 27 dB
    - ODN loss: 5.5.2+20.81= 26.33 dB
    - Maximum power level at OLT Rx: +7 – 1 – 26.33 = – 20.33 dBm
    - Power budget margin: +0.67 dB
    - Damage threshold of OLT Rx: –5 dBm >> –20.33 dBm
    - Conclusions: PX20 ONU receive optical signal within sensitivity limit of their Rx
  - **Upstream (1G)**
    - Power budget: -1 – 1.8 – (– 32) = 29.2 dB
    - ODN loss: 8.36+20.81 = 29.17 dB
    - Maximum power level at OLT Rx: +4 – 1.8 – 29.17 = – 23.17 dBm
    - Power budget margin: 0.03 dB
    - Damage threshold of OLT Rx: –3 dBm >> –23.17 dBm
    - Conclusions: the power budget margin is very small, so the link still can work, PX40 OLT PMD receives optical signal within sensitivity limit of its Rx; Rx operates with large safety margin from damage threshold

Conclusions

- In the worst case scenario:
  - A high-power budget ONU can be connected to a low-power budget ODN, replacing an existing ONU. Using simple numeric calculations included in the set of previous slides for 5 different scenarios, we show that there are no problems with the overload as long as the ODN was designed accordingly (i.e. its loss is close to maximum loss permitted for the given class)
  - A low-power budget ONU is connected to a high-power budget ODN, accidentally replacing a new ONU. Using the same simple numeric calculations, we show that there are scenarios under which the link may not work, if the ODN loss is excessive. In most cases, the link may work, though the link margin is very limited.

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